

SECTION 03410
PLANT-PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

0.1 DESCRIPTION OF WORK

- A.** Work Included: This Section specifies plant-precast structural concrete units, including the following:
1. Hollow-core slab units.
 2. Long-span units.
 3. Structural framing units.
- B.** Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. Section 07842 - FIRE-RESISTIVE JOINT SYSTEMS; joint filler materials for fire-resistance-rated construction.
 2. Section 07920 - JOINT SEALANTS; elastomeric joint sealants and sealant backings.

0.2 SUBMITTALS

- A.** Product Data: For each type of product indicated.
- B.** Design Mixes: For each concrete mix.
- C.** Shop Drawings: Detail fabrication and installation of precast structural concrete units. Indicate member locations, plans, elevations, dimensions, shapes, cross sections, openings, and types of reinforcement, including special reinforcement.
1. Indicate welded connections by AWS standard symbols. Detail loose and cast-in hardware, inserts, connections, and joints, including accessories.
 2. Indicate locations and details of anchorage devices to be embedded in other construction.
- D.** Samples: For each type of finish indicated on exposed surfaces of precast structural concrete units, in sets of 3, illustrating quality of finishes, colors, and textures; approximately 12 by 12 by 2 inches.
- E.** Samples of bearing pads.

- F.** Welding Qualifications: Copies of qualifications for welding procedures and personnel.
- G.** Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- H.** Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
 - 1. Concrete materials.
 - 2. Reinforcing materials and prestressing tendons.
 - 3. Admixtures.
 - 4. Bearing pads.
- I.** Inspection and test reports from independent testing agency.

0.3 QUALITY ASSURANCE

- A.** Installer Qualifications: An experienced installer who has completed precast structural concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B.** Fabricator Qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast structural concrete units similar to those indicated for this Project and with a record of successful in-service performance. Plant certification is required by Precast Concrete Institute; plant subject to inspection by the Engineer.
- C.** Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- D.** Design Standards: Comply with ACI 318 and the design recommendations of PCI MNL 120, "PCI Design Handbook--Precast and Prestressed Concrete".
- E.** Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and camber and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products".
- F.** Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel"; and AWS D1.4, "Structural Welding Code--Reinforcing Steel".

- G.** Calculated Fire Resistance: Where indicated, provide precast structural concrete units whose fire resistance has been calculated according to PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete", or ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies", and is acceptable to authorities having jurisdiction.
- H.** Fire-Test-Response Characteristics: Provide precast structural concrete units that comply with the following requirements:
 - 1. Fire-response testing was performed by UL, ITS or another testing and inspecting agency that is acceptable to authorities having jurisdiction and that performs testing and follow-up services.
 - 2. Fire-resistance-rated assemblies, which are indicated by design designations from UL's "Fire Resistance Directory", from ITS's "Directory of Listed Products" or from the listings of another testing and inspecting agency, are identical in materials and construction to those tested per ASTM E 119.
 - 3. Products are identified with appropriate markings of applicable testing and inspecting agency.

0.4 DELIVERY, STORAGE, AND HANDLING

- A.** Deliver precast structural concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so markings are visible.
- B.** Lift and support units only at designated lifting and supporting points as shown on Shop Drawings.

0.5 SEQUENCING

- A.** Furnish anchorage items to be embedded in other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

0.1 MOLD MATERIALS

- A.** Molds: Provide molds and, where required, form-facing materials of metal, plastic, wood, or another material that is nonreactive with concrete and dimensionally stable to produce continuous and true precast concrete surfaces within fabrication tolerances and suitable for required finishes.

0.2 REINFORCING MATERIALS

- A.** Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B.** Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C.** Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:
 - 1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60, deformed.
- D.** Steel Bar Mats: ASTM A 184/A 184M, assembled with clips, as follows:
 - 1. Steel Reinforcement: ASTM A 615/A 615M, deformed bars.
- E.** Plain-Steel Wire: ASTM A 82, galvanized.
- F.** Deformed-Steel Wire: ASTM A 496.
- G.** Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from galvanized steel wire into flat sheets.
- H.** Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.
- I.** Supports: Manufacturer's bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place according to CRSI's "Manual of Standard Practice", PCI MNL 116, and as follows:
 - 1. For uncoated reinforcement, use CRSI Class 1 plastic-protected bar supports.
 - 2. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

0.3 PRESTRESSING TENDONS

- A.** Prestressing Strand: ASTM A 416/A 416M, Grade 250 or 270, uncoated, 7-wire, low-relaxation strand.

0.4 CONCRETE MATERIALS

- A.** Portland Cement: ASTM C 150, Type III cement mitigated with a pozzolan to prevent alkali-silica reactivity.
- B.** Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33.
- C.** Lightweight Aggregates: ASTM C 330.

- D.** Water: Potable, free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.
- E.** Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- F.** Fly Ash Admixture: ASTM C 618, Class C only.
- G.** Silica Fume Admixture: ASTM C 1240.

0.5 STEEL CONNECTION MATERIALS

- A.** Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
- B.** Carbon-Steel Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished; AWS D1.1, Type A or B, with arc shields.
- C.** Malleable Steel Castings: ASTM A 47.
- D.** Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
- E.** Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.
- F.** Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M, after fabrication, and ASTM A 153/A 153M, as applicable.
 - 1.** Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.
- G.** Welding Electrodes: Comply with AWS standards.
- H.** Accessories: Provide clips, hangers, plastic shims, and other accessories required to install precast structural concrete units.

0.6 STAINLESS-STEEL CONNECTION MATERIALS

- A.** Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
- B.** Stainless-Steel Bolts and Studs: ASTM F 593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless steel washers.
- C.** Stainless-Steel Headed Studs: ASTM A 276.

0.7 BEARING PADS

- A.** Provide bearing pads for precast structural concrete units as follows:
1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore A durometer, minimum tensile strength 2250 psi per ASTM D 412.
 2. Frictionless Pads: Tetrafluoroethylene, glass-fiber reinforced, bonded to mild-steel plate, of type required for in-service stress.

0.8 GROUT MATERIALS

- A.** Sand-Cement Grout: Portland cement, ASTM C 150, Type I or II, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- B.** Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, Portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application.

0.9 CONCRETE MIXES

- A.** Prepare design mixes for each type of concrete required.
1. Limit use of fly ash and silica fume to not exceed, in aggregate, 25 percent of Portland cement by weight.
- B.** Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.
- C.** Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318.
- D.** Normal-Weight Concrete: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): 5000 psi.
 2. Maximum Water-Cementitious Materials Ratio: 0.40.
 3. Slump: 4 inches maximum.
 4. Units subject to freeze-thawing shall be air-entrained. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows, with a tolerance of plus or minus 1-1/2 percent:

- a. Air Content: 3 to 6 percent.
- E. Lightweight Concrete: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 5000 psi.
 - 2. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft., plus or minus 3 lb/cu. ft. (48 kg/cu. m), according to ASTM C 567.
 - 3. Add air-entraining admixture at manufacturer's prescribed rate to result in lightweight concrete at point of placement having an air content as follows:
 - a. Air Content: 4 to 6 percent for 3/4-inch-nominal maximum aggregate size.
- F. Other Admixtures: Use water-reducing, high-range water-reducing, water-reducing and accelerating, or water-reducing and retarding admixtures according to manufacturer's written instructions.
- G. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

0.10 FABRICATION

- A. Formwork: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for pretensioning and detensioning operations. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances.
 - 1. Coat surfaces of forms with bond-breaking compound before reinforcement is placed. Provide commercial-formula, form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces requiring bond or adhesion. Apply in compliance with manufacturer's written instructions.
 - 2. Unless forms for precast, prestressed concrete units are stripped before detensioning, design forms so stresses are not induced in precast concrete units because of deformation or movement of concrete during detensioning.
- B. Built-in Anchorages: Accurately position built-in anchorage devices and secure to formwork. Locate anchorages where they do not affect position of main reinforcement or concrete placement. Do not relocate bearing plates in units unless approved by Engineer.

- C.** Cast-in openings larger than 10 inches in diameter or 10 inches square according to Shop Drawings. Smaller holes may be field cut by trades requiring them, as approved by Engineer.
- D.** Reinforcement: Comply with recommendations in Concrete Reinforcing Steel Institute's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 - 1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
 - 2. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete-placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
 - 3. Place reinforcement to obtain at least the minimum coverage for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
 - 4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E.** Prestress tendons for precast structural concrete units by either pretensioning or posttensioning methods. Comply with Precast Concrete Institute MNL 116.
 - 1. Delay detensioning until concrete has reached at least 70 percent of its compressive strength as established by test cylinders cured under the same conditions as concrete.
 - 2. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
 - 3. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
- F.** Mix concrete according to PCI MNL 116 and requirements in this Section. After concrete batching, no additional water may be added.
- G.** Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 116 for measuring, mixing, transporting, and placing concrete.
- H.** Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 116.
- I.** Comply with ACI 306.1 procedures for cold-weather concrete placement.

- J.** Comply with ACI 305R recommendations for hot-weather concrete placement.
- K.** Identify pickup points of precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint casting date on each precast concrete unit on a surface that will not show in finished structure.
- L.** Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.
- M.** Product Tolerances: Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product tolerances.
- N.** Finish formed surfaces of precast structural concrete as indicated for each type of unit, and as follows:
 - 1. Commercial Finish: Remove fins and large protrusions and fill large holes. Rub or grind ragged edges. Faces are to be true, well-defined surfaces.
- O.** Screed finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections.
 - 1. Apply scratch finish to precast concrete units that will receive concrete topping after installation. After initial strikeoff, transversely scarify surface to provide ridges approximately 1/4 inch deep.
- P.** Recess prestressing tendons a minimum of 1/2 inch, fill recesses with grout, and apply a sack finish to vertical ends of precast concrete units.

0.11 HOLLOW-CORE SLAB UNITS

- A.** Type: Precast, prestressed concrete units with open, hollow cores running the full length of the slab units.
- B.** Furnish units free of voids and honeycombs.
- C.** Provide standard finish to precast concrete units.
- D.** Reinforce units to resist transportation and erection stresses.
- E.** Coordinate with other trades for installation of cast-in items.
- F.** Include cast-in weld plates where required.

- G.** Provide solid, monolithic, precast concrete slab units forming an integral part of hollow-core slab unit system. Design and fabricate solid units to dimensions and details indicated for hollow-core slab units.
- H.** Provide headers of cast-in-place concrete or structural-steel shapes for openings larger than one slab width according to hollow-core slab unit fabricator's written recommendations.

0.12 LONG-SPAN UNITS

- A.** Type: Plant-fabricated, precast, prestressed concrete long-span units.
- B.** Furnish units free of voids and honeycombs.
- C.** Provide standard finish to precast concrete units, unless otherwise indicated.
 - 1. If designed as composite members, broom or rake top finish of precast concrete units for bonding with concrete floor topping.
 - 2. If used as roof members, provide smooth, float top finish to precast concrete units.
- D.** Reinforce units to resist transportation and erection stresses.
- E.** Include cast-in weld plates where required.
- F.** Coordinate with other trades for installation of cast-in items.

0.13 STRUCTURAL FRAMING UNITS

- A.** Type: Precast, prestressed structural concrete framing units.
- B.** Furnish units free of voids and honeycombs.
- C.** Provide standard finish to precast concrete units.
- D.** Reinforce units to resist transportation and erection stresses.
- E.** Include cast-in weld plates where required.
- F.** Coordinate with other trades for installation of cast-in items.

0.14 SOURCE QUALITY CONTROL

- A.** Contractor shall engage an independent testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.
 2. Notification Point - Notify Engineer at least 3 days in advance of testing. Testing may be witnessed by the Engineer.
- B.** Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 116 requirements.
- C.** Strength of precast concrete units will be considered deficient if units fail to comply with PCI MNL 116 requirements, including the following:
1. Units fail to comply with compressive-strength test requirements.
 2. Reinforcement and prestressed tendons of units do not comply with fabrication requirements.
 3. Concrete curing and protection of units against extremes in temperature fail to comply with requirements.
 4. Units are damaged during handling and erecting.
- D.** Testing: If there is evidence that the strength of precast concrete units may be deficient or may not comply with PCI MNL 116 requirements, Contractor shall employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.
1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Engineer.
 2. Cores will be tested, after immersion in water, in a wet condition per ACI 301 if units will be wet under service conditions.
 3. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is equal to at least 85 percent of the 28-day design compressive strength and no single core is less than 75 percent of the 28-day design compressive strength.
 4. Test results will be made in writing on the same day that tests are performed, with copies to Engineer, Contractor, and precast concrete fabricator. Test reports will include the following:
 - a. Project identification name and number.
 - b. Date when tests were performed.
 - c. Name of precast concrete fabricator.
 - d. Name of concrete testing agency.
 - e. Identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength; type of break; compressive strength at break, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

- E.** Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mix that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
- F.** Dimensional Tolerances: Units with dimensions smaller or larger than required and not complying with tolerance limits may be subject to additional testing.
 - 1. Precast concrete units with dimensions larger than required will be rejected if the appearance or function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to comply with construction conditions.
- G.** Defective Work: Precast concrete units that do not comply with requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that comply with requirements.

PART 3 - EXECUTION

0.1 EXAMINATION

- A.** Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

0.2 INSTALLATION

- A.** Bearing Pads: Install bearing pads as precast concrete units are being erected. Set pads on true, level, and uniform bearing surfaces and maintain in correct position until precast concrete units are placed.
- B.** Install precast structural concrete. Shore and brace precast concrete units to maintain location, stability, and alignment until permanent connections are installed.
- C.** Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders using qualified welding procedures.
 - 1. Protect precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
 - 2. Repair damaged metal surfaces by cleaning and applying a coat of galvanized repair paint to galvanized surfaces.

3. Repair damaged metal surfaces by cleaning and repriming damaged painted surfaces.
- D. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units unless approved by Engineer.
- E. Erection Tolerances: Install precast concrete units level, plumb, square, and true, without exceeding the recommended erection tolerances in PCI MNL 127, "Recommended Practice for Erection of Precast Concrete".
- F. Grouting Connections and Joints: After precast concrete units have been placed and secured, grout open spaces at keyways, connections, and joints as follows:
 1. Provide forms or other approved method to retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.

0.3 FIELD QUALITY CONTROL

- A. Testing: Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections.
- B. Notification Point - Field welds and connections using high-strength bolts will be subject to tests and inspections. Notify the Engineer 24 hours in advance of high-strength bolting.
- C. Testing agency will report test results promptly and in writing to Contractor and Engineer.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

0.4 CLEANING

- A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.

1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

PART 4 - MEASUREMENT AND PAYMENT

0.1 MEASUREMENT

- A. Plant-precast structural concrete will be measured as per cubic yard complete in place, including all preparation, reinforcing, formwork, accessories and incidentals.

0.2 PAYMENT

- A. Payment for plant-precast structural concrete will be made at the Contract unit price for the quantities as specified above.

0.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0340.006	PLANT-PRECAST STRUCTURAL CONCRETE	SF

END OF SECTION

NOTES TO THE DESIGNER

- A.** Any request to modify or waive the specification requirements listed below must be approved in writing by the MBTA's Director of Design:

1. None.